Nov. 29, 1960 R. H. SABEL 2,962,091

FLEXIBLE GAS BURNER

Filed Aug. 9, 1954 2 Sheets-Sheet 1

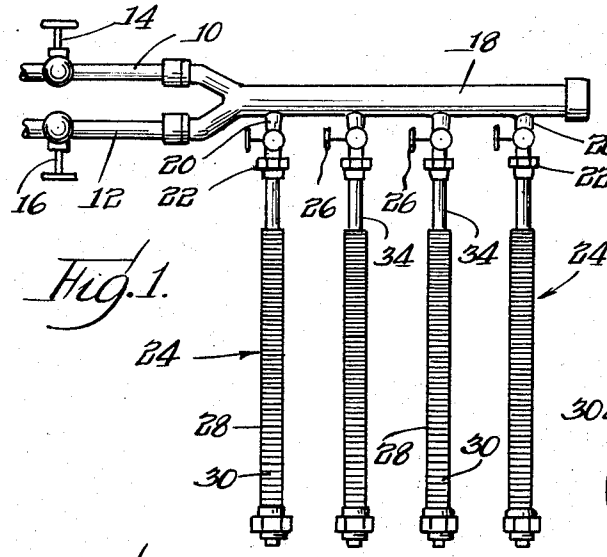


Fig. 1.

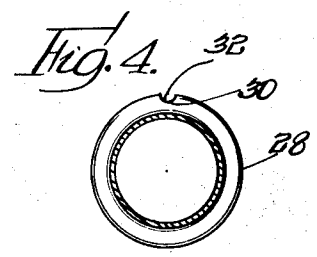


Fig. 4.

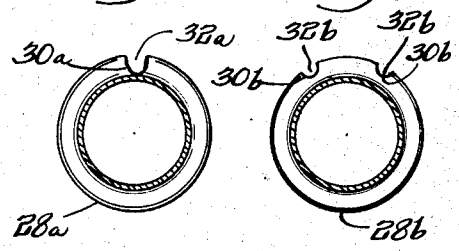


Fig. 5.

Fig. 6.

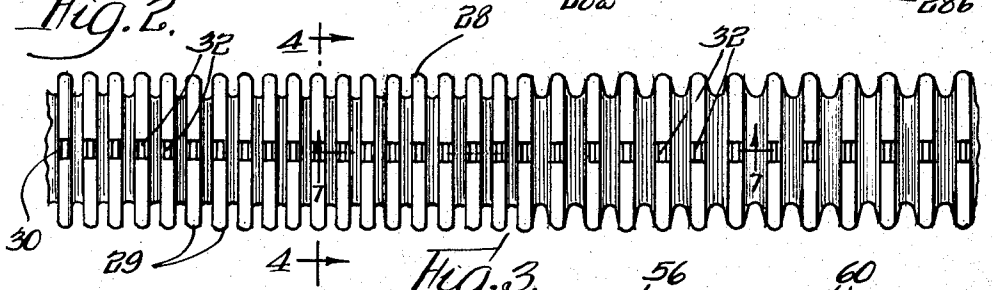


Fig. 2.

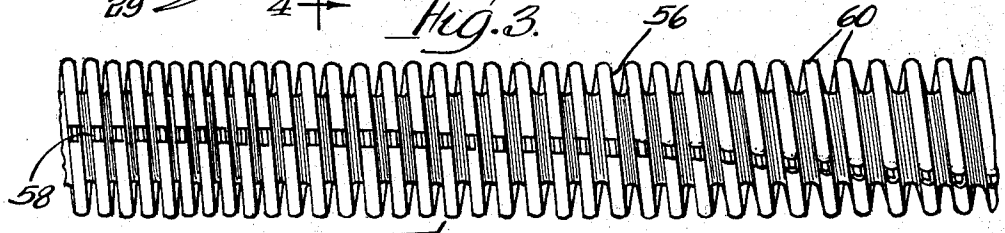


Fig. 3.

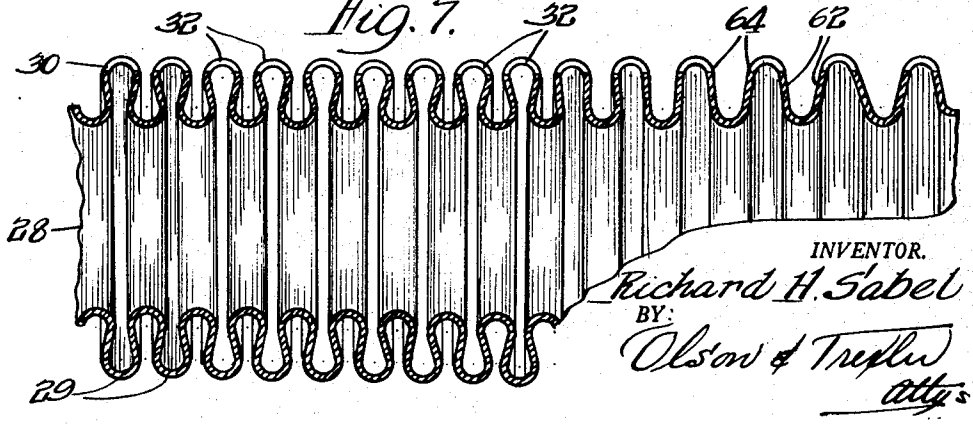


Fig. 7.

INVENTOR.
Richard H. Sabel
BY:
Olson & Treplin
Attys.

Nov. 29, 1960 R. H. SABEL 2,962,091

FLEXIBLE GAS BURNER

Filed Aug. 9, 1954 2 Sheets-Sheet 2

Fig. 8.

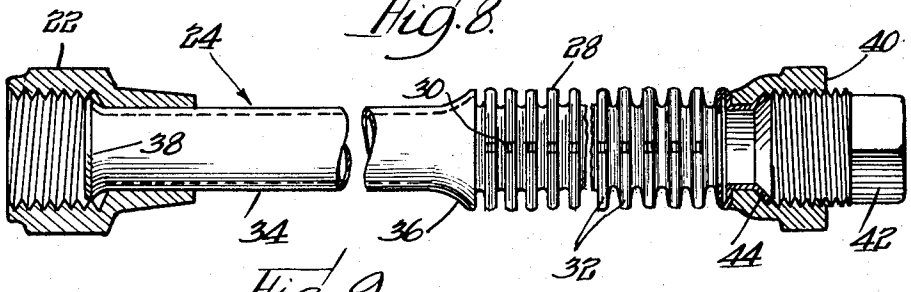


Fig. 9.

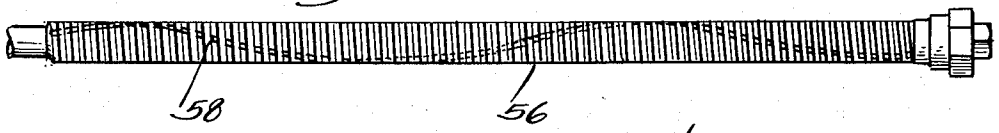


Fig. 10.

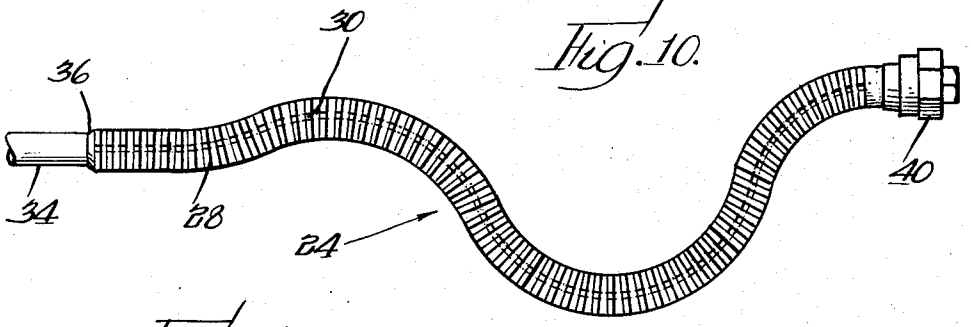


Fig. 11.

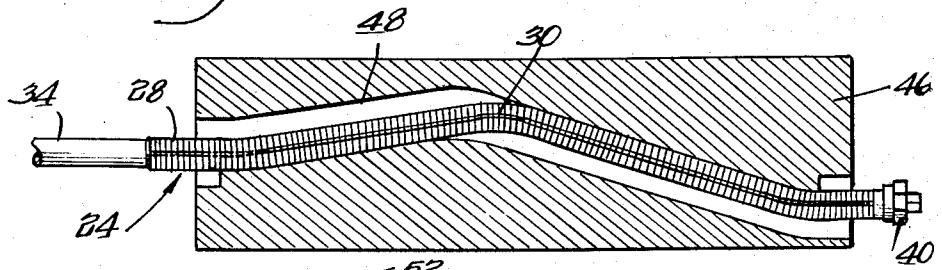
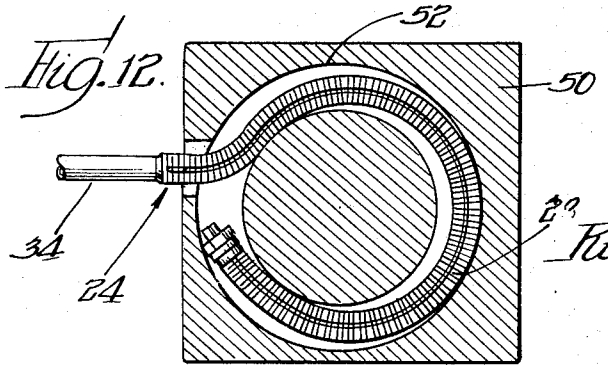


Fig. 12.



INVENTOR.
Richard H. Sabel
BY
Olson & Trexler
Attys

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FLEXIBLE GAS BURNER

Richard H. Sabel, Riverside, Ill., assignor to Flexonics Corporation, Maywood, Ill., a corporation of Illinois

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7 Claims. (Cl. 158—105)

This invention relates to gas burners, and particularly to a gas burner fashioned from flexible conduit for the production of a flexible gas burner assembly.

In various types of industrial heating operations it is frequently necessary to apply a non-uniform heat pattern to the object to be treated. This has conventionally been accomplished by the use of gas burners, of special shape and size, and so constructed as to apply the heat pattern in accordance with the requirements of the object. This practice is expensive, in that it requires the production of gas burners of a number of different shapes and sizes, which frequently can be used only for the installations for which they were produced.

It also frequently happens that the object to be heated includes remotely disposed and inaccessible cavities, requiring a burner of special shape; and in such instances in accordance with conventional practice difficult assembly operations are presented, in the installation and assembly of the burner into the remote and inaccessible cavity to be heated.

In accordance with the present invention a flexible gas burner assembly is provided, fashioned from flexible tubing, which may be variously shaped to accommodate the heating requirements of a particular object to be heated. The burner is also so constituted and arranged that it can be automatically shaped by contact with a shaped surface, whereby to be automatically shaped into a desired contour upon being thrust into an inaccessible or remotely disposed cavity, as will be more particularly hereinafter set forth.

As will more particularly hereinafter appear, the burner can be shaped, or varied in its geometric pattern, both longitudinally and laterally, to conform to a desired flame pattern. Such shaping can be of substantially any pattern desired, and it may involve geometric configurations in more than one plane.

It is accordingly an object of the present invention to provide an improved gas burner, and particularly a gas burner which is flexible in character to conform to a desired flame pattern, and to provide a single burner which can be shaped to a number of different flame patterns, as may be required.

A further object of the invention is to provide an improved gas burner which can be automatically shaped to a desired flame pattern, by contact with the object to be heated.

A further object of the invention is to provide an improved flexible gas burner, of the foregoing type, fashioned from flexible tubing, and wherein the position and size of the gas exhaust openings may be readily controlled, to further vary and control the desired flame pattern; and to provide a flexible burner assembly which is low in cost, and which can be readily manufactured and assembled.

Various other objects, advantages and features of the invention may be apparent from the following specification, when taken in connection with the accompanying

drawings, wherein certain preferred embodiments are set forth for purposes of illustration.

In the drawings, wherein like reference numerals refer to like parts throughout:

Fig. 1 is an assembly view, generally diagrammatic in form, of a gas burner installation incorporating a series of gas burners constructed in accordance with and embodying the principles of the present invention;

Fig. 2 is an enlarged partial detail view of one of the burners of Fig. 1, more particularly illustrating the structure;

Fig. 3 is a view similar to Fig. 2, but illustrating a burner of modified form;

Fig. 4 is a transverse sectional view of the strtucture of Fig. 2, on the line 4—4 thereof;

Fig. 5 is a view similar to Fig. 4, but showing the burner with a gas exhaust opening of increased size;

Fig. 6 is a view, also similar to Fig. 4, but showing the burner tube as provided with a plurality of gas exhaust openings;

Fig. 7 is a further enlarged longitudinal sectional view of the structure of Fig. 2, and taken as indicated by the line 7—7 thereof;

Fig. 8 is an assembly view of the burner of the present invention, more particularly showing the coupling structures, and related parts; and

Figs. 9–12 are illustrative views showing the way in which the burner of the invention may be shaped and arranged in various heating applications.

Referring more particularly to the drawings, in Fig. 1 there is illustrated a gas burner installation comprising an inlet pipe **10** for gas, and an inlet pipe **12** for air, controlled, respectively, by valves **14** and **16**. The pipes **10** and **12** lead to a manifold **18** provided with a series of nozzles **20** adapted to be connected by couplings **22** to a plurality of gas burners constructed in accordance with the principles of the present invention, and which are generally designated by the reference numeral **24**. Each burner connection is provided with an individual control valve **26** by which the flow of the air and gas mixture from the manifold to the individual gas burner may be controlled.

As illustrated in Figs. 1 and 2, each gas burner is fashioned from a piece of metal hose **28** which is annularly corrugated or convoluted throughout its length. These annular corrugations, as indicated at **29**, may be formed in the tube by various means conventionally employed for the production of flexible metal tubing, such as by die rolling, or by hydraulic bulging operations. In accordance with the present invention the tube wall thickness is of such gauge and elasticity in respect to the metal of which the tubing is formed that after being corrugated it may be readily bent laterally or extended or compressed longitudinally, by hand, whereupon it will assume a set so as to be maintained in the position to which it is deformed.

As best shown in Figs. 2 and 4, the tubing **28** is provided along its length with a kerf **30** which engages or penetrates only the apices of the tubing convolutions, whereby to provide a series of gas exhaust openings **32**, one opening being provided for each annular corrugation. The structure is also more particularly shown by Fig. 7 wherein the convolutions **29** of the tube are more particularly shown, and wherein it will be seen that the kerf **30** penetrates only the apices of the convolutions to provide the openings **32**.

The kerf **30** may be conveniently formed, in practice, by any suitable cutting tool, but preferably is formed by grinding a longitudinal kerf into the apices of the convolutions whereby to provide the openings **32**, while at the same time effecting a minimum distortion of the convolution contour.

As will be seen by reference to Fig. 5, illustrating a modified embodiment, the gas exhaust openings may be made larger, to increase the flame density, merely by cutting a deeper kerf into the tubing, as indicated at 30*a*, whereby to form a series of exhaust openings 32*a*, similar to the openings 32, but larger in area. Thus by controlling the depth of the grinding operation, kerfed exhaust openings of varying size may be provided in the apices of the tubing convolutions.

In Fig. 6 a modified embodiment is illustrated, similar to Fig. 4 but wherein the tubing, as indicated at 28*b*, is provided with two longitudinal kerfs 30*b* in circumferentially spaced disposition, so as to provide two sets of longitudinal gas exhaust openings 32*b* into the tubing wall.

As further illustrated in Figs. 2 and 7, it will be seen that the longitudinal spacing of the openings may be varied by the stretching or compression of the tubing, whereby to increase or decrease the longitudinal pitch of the tubing convolutions. Thus, as shown in Figs. 2 and 7, the convolutions at the left end of the tubing are of lesser pitch, and the convolutions at the right of the tubing are of increased pitch, whereby to correspondingly space the kerfed openings 32 longitudinally of the burner structure. As previously stated, in accordance with the present invention the tubing wall structure is so constituted that it will remain in position, upon displacement to a predetermined shape. Accordingly, upon the axial extension or compression of the tubing, as above set forth, the tubing wall remains set to the extended or contracted position, whereby to permanently adjust the gas escape openings to the desired longitudinal pattern or flame density, until such time as the tubing is again stretched or compressed by the application of external forces, to provide a different longitudinal flame pattern.

In Fig. 8 one complete burner assembly is shown. It will be seen that in addition to the flexible tubing 28, the burner comprises a length of straight, non-corrugated tubing 34, which however may be of any configuration and of any suitable length, as desired. Preferably the tubing portions 28 and 34 may be integral, viz., they may comprise a single piece of tubing, only a portion of which is corrugated, or they may be two tubing pieces welded or brazed together at the connection indicated by the reference numeral 36, forming in effect a single tubing structure.

The inlet end of the tubing piece 34 is preferably flared, as indicated at 38, and provided with a coupling piece 22, as previously described, for connection to the intake manifold.

The end of the flexible tubing may be closed in any suitable manner, but preferably this is effected by a coupling body 40 and plug 42, in threaded interengagement, and cooperatively gripping a flared end portion 44 of the tubing wall, to provide a fluid-tight seal.

Figs. 10, 11 and 12 illustrate the manner in which the flexible burner of the present invention may be utilized in service. In Fig. 10 the burner is shown with the flexible tubing portion 28 bent into serpentine form, as for example to provide a generally S-shaped or serpentine flame pattern, as may be desired for a particular installation. In Fig. 11, the burner is shown inserted into a block 46 having an elongated opening or cavity 48 to be heated. It will be seen that the flexible burner portion can be shaped to conform to the block cavity, merely by thrusting the burner into position.

In Fig. 12 the burner is shown in association with a block 50 having a generally circular cavity 52, the flexible burner portion being shown in the position which it automatically assumes as it is thrust into the block cavity.

The flexible burner portion may also be formed of spiral or helically corrugated tubing 56, as illustrated in Figs. 3 and 9. The spiral corrugations may be formed in accordance with standard practices for producing spirally corrugated tubing, following which one or more longitudinal kerfs, as indicated at 58, may be ground into the apices of the convolutions, as previously described in connection with the kerf 32. The manner of functioning of the spirally corrugated or convoluted tubing is the same as that previously described in connection with the annularly corrugated flexible tubing structure, except that with spirally corrugated tubing as the tubing is longitudinally extended from the position which it had when the kerf was cut, the kerf will assume a generally spiral formation. This is indicated in Fig. 3, wherein the right end tubing convolutions have been extended, as indicated at 60, whereby it will be seen that the kerf 58 by such extension assumes an offset or spiral position. The action is further illustrated in Fig. 9 wherein a greater length of the flexible tubing is shown. In this instance the kerf 58 upon extension of the tubing assumes a spiral formation which may assume several spiral turns in a tubing of sufficient length. In certain instances this action, wherein the gas exhaust openings assume a spiral condition proportional to the extension of the tubing, and automatically as the tubing is extended, may be desired.

It will be seen that in either form of the invention, whether annularly or spirally corrugated tubing is provided, the marginal portions of each gas exhaust opening recede away from the opening whereby to minimize heating tendencies of the burner wall, for increased burner life. Thus, referring for example to Fig. 7, it will be seen that the tubing portions as indicated at 62, at the base of the convolutions, are a material distance away from the gas escape opening margins 64, to increase the life of these tubing portions by their remote disposition in respect to the flame.

It will be seen that by reason of the present invention, a flexible gas burner structure is provided which may be readily shaped to conform to a desired flame pattern, and variously shaped to conform to various flame patterns, when necessary. The burner automatically assumes the contour of a cavity into which it is thrust. The structure can be readily fabricated, and easily bent by hand. The size of the gas escape openings, and their number and disposition, can be readily controlled without the necessity for providing punching dies of various sizes and kinds, and without the necessity for expensive die punching operations. Obviously, the kerf may be of any desired configuration such as round, triangular, or square; and the tube 28 may likewise be round, as shown, or of other geometric configuration as may be desired for any particular installation.

It is obvious that various changes may be made in the embodiments of the invention specifically set forth for the purpose of illustration, without departing from the spirit of the invention. The invention is accordingly not to be limited to the specific embodiments shown and described, but only as indicated in the following claims.

The invention is hereby claimed as follows:

1. A flexible gas burner comprising an elongated tubing, said tubing having a rigid section, and a flexible convoluted section having inner and outer convolutions, the convoluted section having discrete flame jet apertures of limited circumferential extent formed in the outer convolutions thereof and opening substantially radially outwardly to provide a series of spaced gas ports in generally longitudinal single line array substantially transversely of the convolutions and leaving the entire remaining major portion of the tubing imperforate whereby to cause the flame pattern to issue from a minute peripheral portion of any longitudinal section of the tubing.

2. A flexible gas burner comprising an elongated tubing, said tubing having a rigid section, and a flexible convoluted section having inner and outer convolutions, the convoluted section having discrete flame jet apertures of limited circumferential extent formed in the outer

convolutions thereof and opening substantially radially outwardly to provide a series of spaced gas ports in generally longitudinal single line array substantially transversely of the convolutions and leaving the entire remaining major portion of the tubing imperforate whereby to cause the flame pattern to issue from a minute peripheral portion of any longitudinal section of the tubing, coupling means at the free end of the rigid tubing section, and closure means at the free end of the flexible tubing section, to provide an elongated gas burner structure.

3. A gas burner assembly comprising a rigid manifold having an inlet and a plurality of outlets, and a plurality of flexible gas burners connected, respectively, with said outlet, each flexible gas burner comprising a length of flexible convoluted tubing having inner and outer convolutions with flame jet apertures of limited circumferential extent formed in the outer convolutions thereof and opening substantially radially outwardly, to form a series of spaced gas ports in generally longitudinal single line array substantially transversely of the convolutions and leaving the entire remaining major portion of the tubing imperforate whereby to cause the flame pattern to issue from a minute peripheral portion of any longitudinal section of the tubing.

4. A gas burner assembly comprising a rigid manifold having a gas inlet and a plurality of gas outlets, and a plurality of flexible gas burners connected, respectively, to said outlets, each flexible burner comprising a length of rigid tubing and a length of convoluted flexible tubing in longitudinal continuation thereof, said tubing having inner and outer convolutions with the outer convolutions longitudinally kerfed at their apices to provide spaced apertures forming the burner outlet and with the apertures disposed in generally longitudinal single line array substantially transversely of the convolutions and leaving the entire remaining major portion of the tubing imperforate whereby to cause the flame pattern to issue from a minute peripheral portion of any longitudinal section of the tubing.

5. A gas burner as defined in claim 4, wherein each of said gas burners is provided with individual valve means for controlling the flow of gas thereto.

6. A flexible gas burner adapted to be coupled to a source of gas supply and comprising an elongated flexible convoluted tubing having inner and outer convolutions with kerfs penetrating the apices of the outer convolutions longitudinally of the tubing to provide a series of spaced gas ports in generally longitudinal single line array substantially transversely of the convolutions and leaving the entire remaining portion of the tubing imperforate whereby to cause the flame pattern to issue from a relatively minute peripheral portion of any longitudinal section of the tubing.

7. A flexible gas burner adapted to be coupled to a source of gas supply and comprising an elongated flexible tubular member of sheet metal convoluted to provide inner and outer relatively closely spaced convolutions, and said flexible member having a longitudinally disposed series of discrete flame jet apertures through the outer surfaces of the outer convolutions with said apertures opening substantially radially outwardly of the flexible member to themselves provide a series of spaced gas ports in generally longitudinal single line array substantially transversely of the convolutions and leaving the entire remaining portion of the flexible member imperforate whereby to cause the flame pattern to issue from a relatively minute peripheral portion of any longitudinal section of the flexible member which is deformable to provide a desired flame pattern.

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